CS 235: Introduction to Databases
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Administrivia
- Three handouts today:
  - Course info, Schedule, Slides.
  - Latest info will always be online!
- Come to class!
- Ask questions!
- Give feedback!
- Have fun!

What is a DBMS?
- A Database Management System manages very large amounts of data and provides:
  - persistent storage,
  - efficient access,
  - concurrent access,
  - secure, atomic access.

Examples
- (Almost) Everything is a database!
  - Banking systems
  - Reservation systems
  - Libraries
  - The Web
- Varying degrees of structure, organization, and efficiency.

Relational Model
- Based on tables, as:

<table>
<thead>
<tr>
<th>acc#</th>
<th>name</th>
<th>balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345</td>
<td>Kate</td>
<td>100680.21</td>
</tr>
<tr>
<td>78643</td>
<td>Rick</td>
<td>89.91</td>
</tr>
<tr>
<td>23500</td>
<td>Tom</td>
<td>55599.02</td>
</tr>
<tr>
<td>34567</td>
<td>Alice</td>
<td>295.48</td>
</tr>
</tbody>
</table>

- Today used in most DBMS's.

Database Marketplace
- Market shares:
  - Oracle 41.3%
  - IBM 30.6%
  - Microsoft 13.4%
  - Sybase 3.1%
  - NCR (Teradata) 2.6%
  - Other 9.0%

Source: IDC
Relational DBMS Market
- Major vendors:
  - IBM: DB2, Informix – 34.1%
  - Oracle – 33.7%
  - Microsoft: SQL Server, Access – 20.0%

Source: Gartner

Three Aspects to Studying DBMS’s
1. Modeling and design
   - Allows exploration of issues before committing to an implementation.
2. Programming
   - Queries and DB operations like update; connectivity
3. DBMS implementation
   - What’s under the hood.
   \[
   \text{CS235} = (1) + (2)
   \]

Entity-Relationship Model
- First step of database design.
- Represent the real world with diagrams.
- Entity corresponds to an object.
- Entity set corresponds to a class.
- Set of similar objects.
- Attribute = property of entities in entity set.
  - Similar to fields of a struct.

E/R Diagrams
- Entity set \(\rightarrow\) rectangle
- Attribute \(\rightarrow\) oval

Relationships
- Connect two or more entity sets.
- Represented by diamonds.

Relationship Set
- The value of a relationship set is the set of connected entities.
  - Think of the value as a table.
  - One column for each connected entity set.
  - One row for each connection.
Multiway Relationships
- Binary relationships are most common.
- But, sometimes we need a relationship connecting 3 or more entity sets.
- Example: relationship among students, courses, TA's.

Multiway Relationships: Example

Is this E/R diagram correct?

3-Way Relationship

<table>
<thead>
<tr>
<th>Students</th>
<th>Courses</th>
<th>TAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>CS 235</td>
<td>Tom</td>
</tr>
<tr>
<td>Rick</td>
<td>CS 235</td>
<td>Kate</td>
</tr>
<tr>
<td>Elaine</td>
<td>CS 235</td>
<td>Tom</td>
</tr>
</tbody>
</table>

Beers-Bars-Drinkers Example

Multiplicity of Relationships

Representation of Many-One
- E/R: arrow pointing to "one."
  - Rounded arrow = "exactly one."
- Other conventions also exist.
Drinkers Have Favorite Beers

Bars

Serves

Frequents

Beers

Likes

Drinkers

name

addr

license

name

manf

Favorite

name

addr

Beers

manf

Attributes on Relationships

Bars

Sells

Beers

price

Prices

price

Sells

Bars

Beers

Attributes on Relationships

A true 3-way relationship.
- Price depends jointly on beer and bar.
- Arrow convention for multiway relationships: "all other E.S. determine one of these."
  - Not sufficiently general to express any possibility.
  - However, if price, say, depended only on the beer, then we could use two 2-way relationships: price-beer and beer-bar.
- Better solution?

Converting Multiway to 2-Way

Necessary in some object-oriented models.
- Create a new connecting E.S. to represent rows of a relationship set.
  - E.g., (Jimmy’s, Bud, $3.50) for the Sells relationship.
- Many-one relationships from the connecting E.S. to the others.
Roles

- Sometimes an E.S. participates more than once in a relationship.
- Label edges with roles to distinguish.

\[
\text{husband} \quad \text{wife}
\]

Drunkers

Married

Notice Buddies is symmetric, Married not.
- Cannot specify symmetric in E/R.
- Should we replace *husband* and *wife* by one relationship *spouse*?

<table>
<thead>
<tr>
<th>Buddies1</th>
<th>Buddies2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>Kate</td>
</tr>
<tr>
<td>Kate</td>
<td>Alice</td>
</tr>
<tr>
<td>Tom</td>
<td>Rick</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

\[
\begin{array}{|c|c|}
\hline
\text{husband} & \text{wife} \\
\hline
\text{Brad}    & \text{Jennifer} \\
\text{Johnny}  & \text{Vanessa}   \\
\ldots         & \ldots           \\
\hline
\end{array}
\]